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ABSTRACT

This study explored the relationship of vocational-technical educational institutions in Ohio with business and industry using high-technology applications. The study attempted to determine what high-technology applications will be adopted by Ohio's business and industry in the next 5 years, what experience the schools have had in working with high-technology industries, what skills are needed by employees and students entering this job market in the next 5 years, and how these educational needs can be met. Personal interviews were conducted with 32 educators and 15 industry executives in the manufacturing area. The study found that although the executives are supportive of vocational education, they do not view vocational education as a resource for training persons for high-technology positions. The executives pointed out that vocational education is usually carried out on the high school level and they would not want high school graduates working on their high-technology machinery. Instead, the executives expect to do most of their own in-plant training for high-technology jobs. They want to employ technical education graduates of two-year or four-year colleges for these positions. The consortium approach between business and education appears promising and has worked well where tried. One job tackled by the consortium approach has been the retraining of instructors to teach high-technology subjects. The executives stressed that students should take mathematics, science, and computer courses in order to qualify for industry training in high-technology companies. This could be provided in a "pre-technical" high school vocational education option. (KC)

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VOCATIONAL-TECHNICAL EDUCATION INTERFACE WITH OHIO'S HIGH TECHNOLOGY BUSINESS AND INDUSTRIAL SECTOR

FINAL REPORT

TO

THE OHIO ADVISORY COUNCIL FOR VOCATIONAL EDUCATION

by

Robert W. McCormick, Ph. D.

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U.S. DEPARTMENT OF EDUCATION
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INTRODUCTION

The most severe recession since the "great depression" of the 1930s has dramatically illustrated the need for increased efficiency, higher productivity and improved quality in the U.S. industrial sector. The current economic recession has been especially severe in Ohio. The steel, rubber, glass and automotive industries concentrated in the state have been particularly vulnerable.

One response to these economic problems has been the call for more high technology industries for Ohio with less dependence upon heavy industries. There appears to be agreement that a sizable percentage of the jobs in the automotive industry have been permanently lost and even with economic recovery, many workers will not be recalled in this and other heavy industries. In addition, some of Ohio's industries have joined the trek to the "sunbelt" of southeastern United States.

Competition from developed countries in western Europe and Japan has become a critical factor. Efficiency in production and high standards of quality are significant factors which have enabled these products to compete so successfully with U.S. products.

The Ohio Advisory Council for Vocational Education has called for revitalizing the economy and has pointed out that industrial leadership is based upon technology and productivity. The Council quite appropriately stated that, "the unique contribution of vocational and technical education is the preparation of youth and adults who have the interest, attitude and skill, to work effectively in America's business and industry, including agriculture(1).

There has been increased dialogue between the business and industrial sector and eductional institutions in Ohio the past two years. This dialogue has ranged from the role of higher education in conducting research for business and industry to the more operational aspect of the Vocational-Technical Resource Consortia developed by the Ohio Department of Education, Division of Vocational Education and the Ohio Department of Development. This system of twenty-three consortia of vocational and technical education institutions was designed to coordinate resources for meeting the employee training needs of new and expanding industries in Ohio. The Ohio Technology Transfer Organization (OTTO) is a network of two year colleges working with the Ohio State University to provide technical assistance to help Ohio's business and industries use modern technology to solve operational problems.

Since vocational and technical education are such significant elements of Ohio's educational system, it seems appropriate to describe and analyze the current efforts of these educational components in fulfilling their role in working with Ohio's high technology business and industrial sector. It is to this end that this study was directed.

DESIGN OF THE STUDY

This study was an exploratory study of the relationship of vocational-technical educational institutions with business and industry using high technology applications.

This study was designed to answer the following questions:

1. What are the primary high technology applications that will be adopted by Ohio's business and industry sector in the next five years?

2. What have been the experiences of vocational and technical education institutions in working with industries with high technology applications?

3. What do industry executives view as the primary skills required and the educational and training requirements for current employees and "new hires" in the high technology applications in their area in the next five years?

4. How is industry meeting these eductional and training requirements now?

5. Which of the education and training requirements identified by industry executives do vocational-technical educators feel they can provide in the next five years?

6. What are industry executives' perceptions of the role vocational and technical education will perform in relation to high technology applications in the future?

7. What are the implications for curricula and programs in vocational and technical education in Ohio?

Personal interviews were conducted with educators and industry executives. The principal investigator traveled to the site of the educator or industry executive for these interviews. Thirty-two educators and fifteen industry executives in the manufacturing area were interviewed.

A complete outline of the design of this study is shown in Appendix A.

THE SOCIAL AND ECONOMIC MILIEU

We are all familiar with the fact that the United States has changed over the past 150 years from an agrarian economy through an industrial economy to today's post-industrial economy. A brief review may, however, be in order. In 1860 about 35 percent of the U.S. labor force was employed in agriculture, while in 1980 less than five percent was so employed. In 1860 about 35 percent of the labor force was employed in industry. This figure rose to over 60 percent in the mid-1940s at the peak of World War II, but declined to less than 40 percent in 1980, about the same percentage as in 1860.

It is in the information-service area where the great increase in employment has occurred. Today, over 55 percent of the workforce is engaged in the information industry, while another five percent is engaged in other service occupations. Information has become dominant in American society. The business of generating, storing, handling and transmitting knowledge and information is a pervasive influence on the U.S. economy.(2) Computer technology is, of course, a primary instrument in this dramatic change. While we may be prone to say that the U.S. economy cannot survive by "taking in each other's laundry," one cannot deny that about 60 percent of the workforce is engaged in information and service related occupations and it seems probable that the percentage employed in the information occupations will increase.

> Coates describes the situation quite cogently:
> (There is a shift) in our own time from an industrial society to a service based society driven by information. Preparation for work in the information society must be different from what has gone before, for the new information technologies are not mere analogs of the carpenter's plane and the mechanic's wrench. The new vocations will not be limited to the physical manipulation of natural and synthetic substances, but will extend to the manipulation of man's (sic) own creations. The work world will change accordingly. . . . Work is moving to smaller locations, suburban locations, even to the home.(3)

Unemployment

The unemployment picture has dominated the news in recent months and at best can be described as depressing. A national unemployment rate of over 10 percent in 1982 and an unemployment rate of over 14 percent in Ohio very likely underestimates the true dimensions of the unemployment

problem. This short-run bad news is more than matched by the fact that the Chairman of the President's Council of Economic Advisers, Martin Feldstein, predicted in December, 1982 that the unemployment rate may take five or six years to drop to the six or seven percent level that prevailed during the early months of 1980. Even this rate is considerably above the four percent considered the highest acceptable limit when the Humphrey-Hawkins Full Employment and Balanced Growth Act was passed in 1976.(4)

Much of the unemployment is attributed to "structural unemployment." All definitions of full employment recognize the existence of unemployment which is sometimes called "frictional unemployment"--people moving between jobs--and which by definition cannot be entirely eliminated. There is also agreement on the existence of some degree of "structural unemployment." Generally speaking, structural unemployment refers to a person who is out of work because the person's skills do not match available jobs. The distinction between frictional and structural unemployment is not sharp.(5)

It is the concept of structural unemployment that is significant for vocational and technical educators. It has been estimated that about half of the six to seven percent unemployment rate set as the likely level five or six years hence will be frictional and about half will be structural. Hence, something on the order of three percent of the national workforce continuously will be candidates for retraining.(6)

Under-utilization of the Productive Capacity of Business and Industry

The under-utilization of the productive capacity of the United States hardly needs documenting. When factories close, when production lines are idled, the productive capacity of an industry is not fully utilized. There is, of course, a positive correlation between unemployment and under-utilization of productive capacity. Two major resources, human and capital, are immobilized. For example, in the steel industry in the U.S. unemployment is hovering at 50 percent of the industry's 450,000 labor force and industry-wide production is about 29 percent of capacity.(7)

There are conflicting views about how we should treat this problem. George Foster, Chairman, Autech Corporation, Worthington, Ohio states:

> Some are saying that we should walk away from our aging manufacturing base and concentrate our growth in the communications and information technologies and the service industries. Still others are saying we should import more blue collar jobs by bringing Honda and other foreign manufacturers to the State (of Ohio). In my view, that doesn't

> get the job done. In fact, this is really a form of reverse colonialism. The engineers, the technology and also the profits remain with a foreign company. It does not build for leadership in the marketplace. . . .
> For renewal of our growth, we must look to today's emerging technologies for development of new products and new manufacturing methods.(8)

There is no question that much of the manufacturing capacity in the U.S. and in Ohio is outdated with aging and inefficient technology. Most agree that the destruction of the manufacturing facilities in Germany and Japan during World War II provided these countries with a competitive advantage over the U.S. today.

One reaction to the under-utilization of our productive capacity is the tendency for those companies which intend to attempt to compete in the market place to take advantage of the time when the capacity is not in use to introduce automation into the operation. Many executives maintain that factory automation is the key to the survival of the U.S. industry. While the technology is available today to accomplish this goal, the high investment cost and the slow payback time created by the depressed economy prevents some companies from making changes at this time. Many indicate they are waiting until there is an up-turn in the economy.

It has been argued by management executives that direct labor costs must be reduced by 50 percent if many industries are to survive. Automated materials handling and robots will be installed to reduce this labor cost. This action may preclude the "call-back" of the relatively unskilled assembly line worker who had been making $20.00 to $25.00 per hour. This person will certainly require retraining, if the person is to obtain productive employment.

Competition in the International Market

There are many factors which have placed the U.S. at a relative disadvantage in the competition in the international market. Certainly the strong U.S. dollar, created in part by high interest rates in the U.S., has contributed to this problem. There is a litany of other factors which could be enumerated. The two factors which seem most relevant to this report and which may, indeed, be most important to our ability to compete internationally, are 1) a serious decline in the productivity of the U.S. society and 2) a serious deterioration in the quality of the products and services we produce.

The decline in productivity cannot be attributed solely to either labor or management. Both share the responsiblity for this decline. Labor in many instances has demanded increased wages without an increase in productivity. Management has taken the short term view and failed to invest adequately in research and development and in new equipment and technology so that the firm could pay a quarterly dividend to stockholders. This dilemma in a sense feeds on itself. As some have suggested, we have been "eating our seed corn!" The wage-price spiral created by the actions of labor and management created inflationary pressures on the economy and when we appropriately "put the brakes" on inflation, the net result has been high unemployment and a high rate of bankruptcy among firms.

As has been suggested previously, it is patently clear that if many U.S. companies are to compete, automation and the installation of high technology applications will be essential. Such actions are currently under way. The automotive industry is installing robots. Machine tools in use are either NC (nummerically controlled) or CNC (computer numerically controlled). Laser cutting devices are replacing the traditional methods.

The need for improvement in quality control is very evident in Ohio and U.S. industries. During World War II in the labor intensive manufacturing plants where the government paid "cost plus" for armaments, one out of every three persons on the production line was an "inspector." In other words, one-third of the personnel on that line was engaged in a form of quality control. Even using this system, there were many "throw away" parts and much waste. The U.S. economy can not tolerate this level of inefficiency today.

The "quality circle" concept of the Japanese has been studied intensively by Ohio and U.S. industry. Greater employee participation in decision making regarding the production of the final product is a practice that has been re-emphasized recently. This is not a new concept, nor is it one that is easy to manage effectively. Some level of control must be shared with the workers, even though the manager retains the full responsibility for delivering a quality product.

It must be emphasized that any attempt to import the Japanese model of production intact seems doomed to failure in the United States. Much of the effectiveness of the very successful Japanese thrust for efficiency is culturally based.

Arthur S. Golden has analyzed the Japanese industrial model and states:

> But though the Japanese are undeniably a remarkable people, their society and ours are very different, and simple emulation of the Japanese will not work. It would mean trying to transplant social values

> incompatible with our own. . . . For Americans, the rules by which the Japanese live would be almost inconceivable. . . . (There is) a group consciousness central to Japanese social values. This group consciousness enables the Japanese to work so well together that they often put American industry to shame. . . . But it also means that each member of the group pays a hefty price. The first sacrifice any Japanese must make is to be stripped of much of his (sic) individuality.(9)

Demographics

The current level of unemployment in Ohio and the U.S. makes it possible for any industry to be quite selective in the persons it employs. This condition leads to the tendency for business and industry to employ persons who are over-qualified for the job to be done.

Lest we be lulled into feeling that this will be true in the future, it seems important to look at the demographics of our society.

Demography, the study of births, deaths, marriages, divorces and other vital statistics, provides indications about the future of our workforce. The so-called "baby boom" cohort (persons born 1950-1959) is now contributing to the relative scarcity of available entry-level jobs. The "baby bust" cohort is generally described as those born between 1970 and 1979. By the year 2000 when this baby bust cohort enters the workforce, there will be a shortage of entry-level workers.

The baby boom cohort who will be 40 to 50 years of age in 2000 will be caught in an upward crush of middle management. There will be many workers with skills to move upward but they may be thwarted by limited opportunities. These factors have significant implications for education and training.

Women's entry into the labor force on a parity with men is changing the makeup of the workforce

As suggested earlier, the introduction of automation, with increased robots and computers will create some displacement of workers. While these innovations may well create more jobs than they eliminate, the persons displaced likely will be unprepared to accept the jobs created by these new technologies.

The concept of equality of access for women, minorities and the handicapped will continue to be an important factor in employment. High technology applications such as robots and computers are indifferent to race, religion, sex, national origin and other pesonal attributes.(10)

The foregoing social and economic factors contribute to the milieu in which one functions today. These factors must be considered when we look at the role of vocational and technical education as it works with Ohio's high technology applications in the business and industrial sector.

EVOLUTION OF HIGH TECHNOLOGY APPLICATIONS

The rhetoric surrounding the term "high technology" in today's society suggests that this concept has come forth within the past two years in a fully developed state. If educators accept this notion, they will quite likely develop a "knee jerk" response that has characterized many of the respones of our society to the educational, social and political ills that plague us.

The concept of high technology did not spring up over night. The use of the term "high tech" may have become popular recently but the underlying concepts have evolved over time. It has been suggested that in 20,000 B.C., chipping flint was high technology. John Deere's steel plow was high technology in the nineteenth century and more recently the transistor developed in 1948 by Bell Laboratories was a major ingredient in the development of our current high technology applications.

High Technology: Economic Shibboleth or Salvation?

Contemporary news media have devoted much attention recently to the ability of high technology to improve the local, state and national economy. There has been an almost unbelievable level of hyperbole about high technology industries as the salvation of a given area.

The current classic examples of areas which have been successful in attracting and developing high technology industries are the Raleigh-Durham-Chapel Hill metropolitan area of North Carolina, known as the Research Triangle, the "Silicon Valley" in California (related to Stanford University) and Route 128 in the Boston area (related to M.I.T.).(11)

If these areas are viable general models for economic salvation, it would seem that many other metropolitan areas would have joined this high technology approach over the past fifteen years. Apparently this has not happened, since the same three metropolitan areas were used to illustrate successful scientifically oriented manufacturing "spin-off" companies in 1967.(12) The key point is that while one should not discourage government from seeking to attract high technology industries to an appropriate metropolitan area, this approach is not likely unilaterally to solve the economic problems of the United States, the State of Ohio or even a specific metropolitan area in Ohio.

Attracting high technology industries to replace the "basic industries" and "heavy industries" has really become a

shibboleth for government, business and industrial leaders. Slogans and rallying cries may be quite useful in creating a general climate for action or in setting an emotional tone for a state or community. In fact, the Churchillian rhetoric in the summer of 1940 may have been almost as important as the courageous actions of "the few" of the R.A.F. in preventing the German invasion of the British Isles.

One must keep in mind that the so-called "high tech" industries are not immune to economic recession. This was demonstrated dramatically in the autumn of 1982 when the President of the U.S. visited a Columbus, Ohio "high tech" industry to call attention to this means of economical stability. Shortly after the President's visit, the plant announced lay-offs of personnel because of a decline in orders.

Another important factor to consider is the fact that every metropolitan area in the U.S. cannot be a high technology center. This would be roughly equivalent to every student in a class scoring "above average" on an examination. Some diversity has merit as a stabilizing influence upon an area's economy.

A central point is that slogans and rallying cries do not provide a basis for analyzing the vocational and technical education needs of a state or area. If one looks for high technology industries, one may well overlook high technology applications which are taking place in industries which may not be classified as "high tech." For example, most persons, including government, business and industrial leaders, do not consider the automotive industry a high technology industry. Yet, when one looks closely at this industry today, one finds that the automotive industry is frequently leading in the installation of high technology applications.

The conclusion is clear that educators need to have a way of analyzing the high technology applications and cannot become caught up in the rhetoric of campaigning for high technology industries as a salvation for an area's economy or as a means of economic development.(13)

A clear conceptual framework for analysis is essential, if vocational and technical educators are to make appropriate long-term decisions about the directions of their programs.

Industrial Innovation

Industrial innovation is inextricably linked with the concept of high technology. The term innovation means the process of discovering a phenomenon, a fact or to discover or create an idea. The term innovation means the process of using the invention and translating it into an impact on the economy.

It has been established that most technological innovations are based upon well-known, not too recent,

scientiic and engineering knowledge. Also, more than two-thirds of the discoveries (inventions) which resulted in important innovations were made by isolated individuals working alone or within very small companies. There are contradictory examples, such as the emergence of the microelectronic industry as a multi-billion dollar industrial enterprise, following shortly after the discovery of the transistor by Bell Laboratories.

Some generalizations can be made about the innovator, the person who attempts to place an invention into the stream of the economy. This person is often an anti-establishment type with a strong technical background but less skilled in management. This person is stronger at producing technical products than at marketing those products.

It has been estimated that about half of the industrial innovations are designed to improve productivity and about half of the innovations lead to new products, new processes or completely new industries.(14)

Diffusion of Industrial Technology

There has been extensive research on the diffusion of innovations. The researchers generally agree that there is a differential rate of diffusion of a technological innovation based upon; 1) the needs of the potential users, 2) the ease of integrating the new technology into the existing systems, 3) the cost of adopting the innovation (cost in terms of human as well as fiscal resources) and 4) the perceived cost/benefit ratio resulting from adopting the innovation.

Various labels are used to identify the time at which industries adopt innovations. Some adopt early, some adopt late and some never adopt the innovation. In many cases the non-adopters quietly go out of business.(15)

Innovations seem to be adopted at an accelerated rate by firms during times of perceived crisis. Hence, one can assume that there will be a higher rate of adoption of innovations and a higher rate of introduction of high technology during the current economic recession than would occur during better economic conditions. This increased rate of adoption would occur, of course, only in those firms that plan to compete in the market in the future. The non-adopters would be those who will likely go out of business, merge or abandon the product line related to the area of the innovation. It is also quite possible that firms will slow the rate of adoptions when the economy improves and they feel their firm or product line is competing very well and is not threatened.

Figure 1 shows the several categories or levels of innovativeness. It is essential to understand that innovativeness is a continuous variable and partioning this variable into discrete categories is only a conceptual device that enhances the discussion of the process.

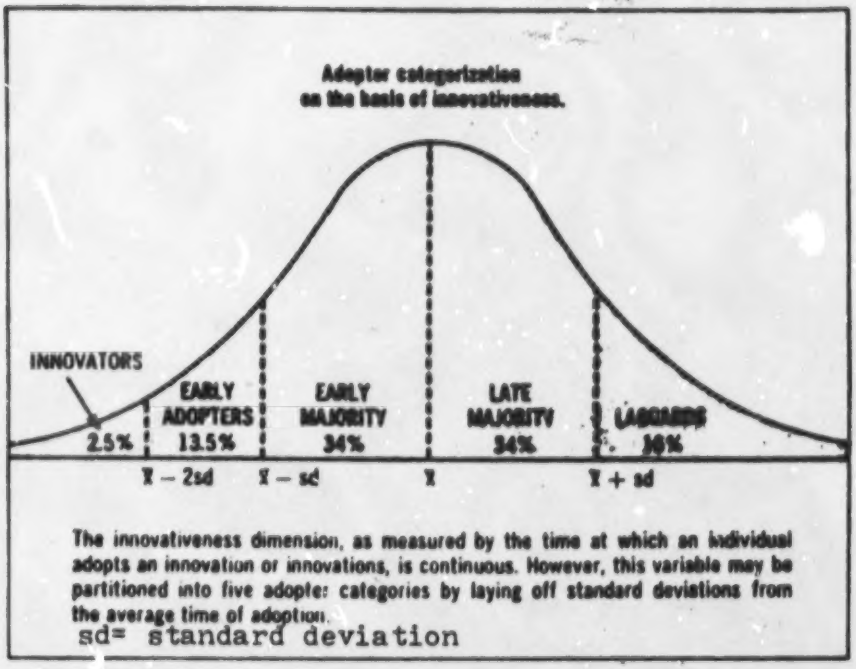
Adopter categorization
on the basis of innovativeness.
INNOVATORS
EARLY ADOPTERS 13.5%
EARLY MAJORITY 34%
LATE MAJORITY 34%
2.5%
X − 2sd
X − sd
X
X + sd
The innovativeness dimension, as measured by the time at which an individual adopts an innovation or innovations, is continuous. However, this variable may be partitioned into five adopter categories by laying off standard deviations from the average time of adoption.
sd= standard deviation

Figure 1--Adopter Categorization on the Basis of Innovativeness

Source: Everett M. Rogers and F. Floyd Shoemaker, Communication of Innovations. (New York: The Free Press, 1971).

The process involved in the diffusion of innovations can be applied directly to the concept of the adoption of high technology applications. The next section will combine the concepts set forth into a conceptual framework designed to aid vocational and technical educators in making curriculum and program decisions.

A CONCEPTUAL FRAMEWORK FOR THE ANALYSIS OF HIGH TECHNOLOGY APPLICATIONS

If one is to conduct a meaningful analysis of the role of vocational-technical education in working with high technology business and industry, it is essential to strip away the rhetoric and arrive at some rational conceptual framework for this analysis. The following is submitted as a useful framework.

As one reviews the current spate of reports, brochures and advertisements extolling the virtues of high technology, one realizes that there is a strong suggestion that a business or industry is either a high technology operation or something else, presumably a "low technology" operation. There is a clear implication that this is a dichotomous situation. To view the concept of high technology as a dichotomous variable (high-low) is quite inaccurate. Actually, we are looking at a continuous variable ranging from relatively low sophistication to a relatively high level of sophistication. Further, high technology is a dynamic concept. The high technology applications of today will be obsolete at some point in the not too distant future.

This discussion is not simply a matter of semantics but involves significantly different analytical perspectives. If high technology is a separate entity from the rest of the technological operations in today's society, then the implications for vocational-technical education will be markedly different than if we view this function as a continuum which is constantly changing over time.

There has been extensive research conducted and published on the communication and adoption of innovations. This research has been conducted in education, medicine, business and industry and in agriculture.

> THE MEASURE OF INNOVATIVENES, THE DEGREE TO WHICH A BUSINESS OR INDUSTRY IS RELATIVELY EARLY IN ADOPTING (INSTALLING) A NEW TECHNOLOGICAL APPLICATION COMPARED WITH OTHER COMPANIES IN THE SAME INDUSTRY, PROVIDES A CONCEPTUAL FRAMEWORK FOR THE ANALYSIS OF HIGH TECHNOLOGY APPLICATIONS.

When we speak of high technology in this report we really mean high technology applications which have been developed.

There are certain component technologies which can be identified as important for vocational and technical education. These are:

1. Computer technology
2. Microelectronic (microprocessor) technology

3. Laser technology
4. Pneumatics
5. Hydraulics
6. Mechanics

In the field of manufacturing, these component technologies in various combinations provide the major new high technology applications with which vocational-technical education will be concerned in the next three to five years. For example, robotics, microcomputers and computer-assisted-design all combine elements of these component technologies.

If we think of high technology applications as the products of the innovation process, we can be more precise in our analysis and more helpful in our recommendations for vocational and technical education.

If we consider the most innovative companies or those companies adopting a new technological application most quickly as the top 15-25 percent of the companies in an industry, we arrive at a working definition of high technology applictions.

> HIGH TECHNOLOGY APPLICATIONS ARE THE STATE-OF-THE-ART TECHNOLOGY FOR THE 15-25 PERCENT MOST INNOVATIVE COMPANIES IN AN INDUSTRY.

The figure of 15-25 percent of the companies designated as most innovative was not determined in a capricious manner. As indicated in Figure 1, there are 16 percent of the cases included in the innovator and early adopter categories. Essentially, this is the mean minus three standard deviations in a normal distribution. In straightforward language, one should look at the most innovative companies.

This definition can provide a guide for vocational and technical educators as they develop curricula and programs. Certainly educators must work closely with the most innovative companies in their area and determine the movement of technogical advances in these industries through close interaction with representatives of these companies. This is an important but insufficient condition. Program directors and instructors in these areas will need to keep current with the trends in the industries through reading and participation in professional development activities. It would seem most desirable for someone at the state level to monitor changes in technological innovations in relevant areas. This monitoring must be done on a state, national and perhaps international level. Persons who expect to be meaningfully involved in this dynamic area will need to be able to follow the changes carefully.

The concept of a dynamic program related to high technology applications includes changes in the current

program and curriculum but even more important is the notion that persons interested in maintaining their literacy in this field and those who wish to work in this field must be committed to the concept of training, re-training and updating on a regular basis. The concept of terminal education is not useful and is, in fact, destructive if one wishes to work or teach in this area.

When one accepts the concept that today's robots represent today's high technology application and there will be continued refinement and modification in their design, operation and maintenance, the implications for vocational and technical education programs and curricula can be meaningful for the present and the future. The same concept is applicable to other high technology applications.

CURRENT AND POTENTIAL HIGH TECHNOLOGY APPLICATIONS IN OHIO

As suggested earlier, the high technology applications now operative in Ohio result from combinations of the more basic technologies. Computer technology and the area of microelectronics are two important basic technologies. The first large-scale digital computer was completed in 1944.(16) It was the result of the joint efforts of Harvard University and International Business Machines. By today's standards it was slow, huge and very inefficient. The first electonic computer was built by the University of Pennsylvania in 1946. It was built to calculate artillery firing tables and cost over half a million dollars. Today, almost any home computer costing a few hundred dollars can outperform that machine.(17) In 1948 the invention of the transistor by Bell Laboratories, the research arm of American Telephone and Telegraph (A.T.& T.), was announced. Three years later, Western Electric, A.T. & T's manufacturing arm, began commercial production. This development sparked the increase in commercial use of microelectronics.(18) In the late 1950s several persons developed a process for etching a large number of transistors on a piece of silicon. In 1971 the microprocessor was unveiled. This placed the entire central processing unit (CPU) of a simple computer on one chip smaller than the end of one's little finger. By 1975 the first microcomputer had been developed. Today, microcomputers are moving rapidly into small businesses and into millions of homes.

The above brief sketch of the development of the microcomputer reinforces the fact that high technology applications develop over time.

The applications which follow were identified through the interviews with educators and industry executives in November and December, 1982. One should keep in mind that there are quite likely high technology applications in the process of development at the present time. Many, if not most, of these applications are proprietary in nature and

information about them would not surface in any interview. For example, the concept of molecular engineering is a technology which builds devices from the bottom up. It is a technology of the tiny, arranging a device atom by atom rather than by herds of atoms. A single circuit in a microcomputer holds trillions of atoms. Clearly there is research and development in the molecular engineering field which is progressing both in the public and the private sector. The high technology applications of the future quite likely lie, in part, in this area.(19)

High Technology Applications in Manufacturing

The following are the major high technology applications operative in Ohio's manufacturing area:

1. Computer-aided-design (CAD)
2. Computer-aided-manufacture (CAM)
   a. Numerically controlled machines (NC)
   b. Computer numerically controlled machines (CNC)
   c. Robots
3. Laser devices
4. Microcomputers

Computer-aided-design and computer-aided manufacturing are revolutionizing manufacturing. CAD not only speeds up the laborious process of drafting, it also enables the designer to simulate various aspects of an object or assemblage by rotating, disassembling, and reassembling it on a computer screen, as well as testing it under a variety of known, simulated conditions.

Computer-aided-manufacturing involves computer control of production machines, ranging from machine tools running on punched tape instructions to robots that can be programmed to perform a variety of complex industrial tasks. Such robots outperform human operators in speed, accuracy and dependability in many tasks. When CAD and CAM are linked together, their advantages are increased.(20)

Not all high technology is the electro-mechanical variety. One finds in manufacturing a strong emphasis on statistical quality control. In several manufacturing areas, hourly rate employees with only a high school education but with many years of experience, are being taught on the job, and are expected to use, rather complex statistical concepts. The concepts include measures of variability (standard deviation)and linear regression.

CAD has existed for over fifteen years. It is only in the past few years that turnkey systems have been available. With the advent of these turnkey systems, even small companies can use this technology.

Robots are currently being used primarily for welding and painting on assembly lines. The automotive industry is a key user.

Microcomputers are becoming almost as numerous as

telephones in a manufacturing plant. In many plants, each foreman has either a microcomputer or a terminal linked to a mainframe computer which provides immediate access to information. Even very small companies (50 employees or less) have a number of microcomputers in use for manufacturing.

Lasers are in use as cutting devices and as scanning devices. Applications of this technology have not developed as rapidly as some of the others but expansion in this area may be anticipated.

High Technology Applications in Service Areas

The applications which have shown the most adoptions in the service areas are:

1. Information Area (Telecommunication)
   a. Data networks
   b. Orbital communication satellites
   c. Electronic transfer of funds
   d. Electronic newspaper printing and book publishing
   e. Electronic shopping and postal service
   f. Use of optical fibers and cables
   g. Home microcomputers
2. Data and Word Processing Equipment
   While this is part of the "information" category, the rapid introduction of this technology in the business and office area warrants special attention of vocational and technical educators.
3. Medical Electronics
   Operation, calibration, maintenance and repair of medical electronic equipment of ultrasound, thermal and x-ray diagnostic machines and cardiovascular and other monitoring devices.

As suggested earlier, there has been an increase in the information and service occupations and employment in this area will likely increase as a percentage of total employment.

It is clear that there are many high technology applications now operative in the information area and it is quite likely that these applications will increase in the future. These high technology applications will certainly change the nature of the information related occupations in very dramatic ways. Whether these changes will be desirable or not remains to be seen. Some suggest that the foolproof software for word processors reduces the work to "something anyone can do." Others argue that the clerical or secretarial worker can be released from certain disagreeable tasks and freed for more important administrative tasks such as verification, planning and organization.(21)

Research and Development Mechanisms

In addition to the research and development efforts of the major industries in Ohio, there are many laboratories, institutions, and agencies in government, business and

education conducting research. The following are some of the major efforts:

1. Universities-
   Ohio State University
   Case Western Reserve University
   University of Cincinnati
2. National Aeronautics and Space Administration (NASA)
   Lewis Research Center

   Research on adapting space technology to fill the layperson's needs.

3. Case Western Reserve/Cleveland Clinic/University Circle Complex in Cleveland

   Research on advanced medical procedures.

4. Institute of Polymer Science-University of Akron

5. Battelle Memorial Institute, Columbus

In addition to these established research organizations, a new organization has been developed to aid in keeping Ohio up to date with technological change. The Technology and Productivity Center (TAPCOHIO) is an independent, not for profit, privately controlled educational and scientific organization to promote service to existing and emerging Ohio firms. TAPCOHIO is intended to be the developer, maintainer and entry point for a network of technology and productivity capabilities.

The following are the goals of TAPCOHIO:

1. Accelerate the application of available and emerging technologies to existing manufacturing and business concerns.

2. Stimulate the development of new product companies.

3. Assist in attracting technology companies to Ohio.

4. Develop a public perception of Ohio as a good place to start and grow high technology businesses.

5. Fully identify and communicate the technical, research and financial capabilities in Ohio to those industries, entrepreneurs and others who need them.

Since the Center was organized in late 1982, it is not possible to evaluate it effectiveness. Perhaps the most important fact is that there appears to be a strong interest in facilitating the development of companies which use high technology applications and those which will contribute high technology capabilities.

The existence of these organizations suggests that the level of sophistication of the technology in Ohio will continue to increase.

ROLE OF OHIO'S EDUCATIONAL SYSTEM WITH HIGH TECHNOLOGY APPLICATIONS

Ohio's public educational system can be viewed as a continuum from kindergarten through professional and graduate education to a sizable program of adult and continuing eduction. The educational level of kindergarten through high school, including adult basic education, adult vocational education and community education, while governed by local boards of education, is the general domain of the State Board of Education and the Ohio Department of Education. The collegiate level, beginning with technical and community colleges and extending through professional and graduate education, is governed by boards of trustees for each institution but is the general domain of the Ohio Board of Regents.

While one can outline the general functions of the several elements of this public system of education in Ohio and find concensus about the functions in a general way, when one looks operationally at the function of a specific unit, it is clear there are points of conflict and competition. These points of conflict occur at many levels in the spectrum including competition and overlap between vocational education and the technical and community colleges. While this is certainly not universally true, it is a clearly observable phenomenon.

Functions of Universities

There appears to be a concensus about the role of universities in high technology. This role is one of research and the education of scientifc and engineering talent to design and develop the high technology applications.

Functions of Technical and Community Colleges

The technical and community colleges are preparing to serve the education and training market created by the introduction of high technology applicat ons. These institutions see this as an important development for students working toward an associate degree and for the development of retraining programs for workers in industry. The term "technician" has been used rather consistently to mean a graduate of a technical and community college with an associate degree. This terminology provides an identification upon which these institutions plan to build.

Most technical and community colleges are planning to move into the high technology applications area. The actual

programs are still somewhat limited at this time. Many technical and community colleges do not indicate an intention to change the name of their curriculum from "Electro-Mechanical" to "Robotics", for example, but may well build a robotics option into the existing curriculum.

Technical and community colleges express the intention to produce graduates and train persons who can perform the operation and maintenance functions with high technology applications in the manufacturing areas. There are efforts in other fields, such as bio-medical technician, but the major thrust is in the manufacturing areas.

While technical and community colleges are moving into the high technology appplications in the engineering technologies, there is also some evidence that these higher education institutions continue to support programs which appear to be of "less than college level." Keyboarding is a skill which is widely applicable in typing, word processing, operating a microcomputer and other occupational areas. It seem inappropriate to award associate degree credit for skills that should be learned at the secondary level.

Functions of Vocational Education

Vocational education, particularly in urban areas, has not completely defined its role in working with high technology applications in the manufacturing area. Some vocational educators are concerned about their role and anticipate some loss of students or increased difficulty in placing students unless some modification in the curriculum is made.

There has been considerable change in the curriculum and program related to high technology applications in the information-service areas. Most vocational students have access to microcomputers and those in business and office education have experience in the use of word processors.

Vocational education in Ohio has a strong interest in training personnel who will operate, maintain and repair high technology equipment in the manufacturing areas. Based upn observation of the current situation, this vocational education objective may be difficult to achieve.

Let us consider computer-aided-design and the robot. If one is to operate CAD, one would be involved in designing some object or system. If one is to operate a robot, one really is the person who programs the computer to control the actions of the robot. Robots are their own operators in the traditional sense. At this point in time, persons involved in these functions will require additional formal education beyond a high school education or will be a journeyman employee who has had much additional training.

A realistic approach would seem to be that vocational students in high school interested in working with high

technology applications in manufacturing should have a thorough grounding in the basic technologies and in mathematics, science and communication skills plus a commitment to pursue additional education at some point in time following high school graduation.

Understanding of Functions Among Elements of the Educational System

While it would be unfair to label the conditions surrounding the division of functions among Ohio educational units as confused, it is quite clear that there is a lack of understanding of what each element in the system is doing. There are articulation agreements between various elements of the system. These agreements exist between vocational education and technical and community colleges in most areas. The extent to which these agreements are useful in expediting the flow of students from vocational education to postsecondary technical education is subject to some question. Given the opportunity to choose, technical and community colleges would prefer the high school graduate who has completed four years of English, four years of mathematics and a concentration in the physical sciences. Vocational education is designed for job placement of its students immediately upon graduation from high school.

INTERACTION OF VOCATIONAL-TECHNICAL EDUCATION AND BUSINESS AND INDUSTRY

Close interaction between educators and business and industry has been an important element in the educational process in vocational and technical education for many years. The Ohio Advisory Council for Vocational Education stresses that, "in this period of rapid technological and operational change, it is essential that the schools work in closer relationship with business, industry and labor in their respective communities." (22)

In general, there is evidence that vocational and techical educators have had an increasing level of contact with personnel in industries working with high technology applications. The amount and intensity of the contact varies rather widely from school to school and from one geographic area to another.

The findings presented in a generalized way below are based upon on-site, personal interviews with industry executives. The industry executives interviewed ranged from company training directors to chairmen of the board. The size of the companies ranged from those employing less than fifty persons to those employing several thousand. **IT MUST BE EMPHASIZED THAT ALL OF THESE INDUSTRIES WERE ENGAGED IN MANUFACTURING PRODUCTS WHICH INVOLVED HIGH TECHNOLOGY APPLICATIONS.**

Industry Perceptions of Vocational Education

Industry executives are quite supportive of vocational education as a part of the educational system. They believe this is a very important component of that system.

The evidence clearly indicates that the industry executives interviewed do not view vocational education as a resource for training persons for high technology positions. This is true in today's economy. Future demographic trends may make some changes in this perception.

Industry executives point our that vocational education in Ohio is conducted at the high school level. For example, the training director of one automotive company which is installing a number of robots asserted that he didn't want high school graduates working on the robots in that plant.

Industry executives are seeking persons with postsecondary training and experience for the positions responsible for operating and maintaining high technology equipment in manufacturing. At this point in time it seems unlikely that a high school graduate with vocational education would be employed in the operation and maintenance of high technology equipment in manufacturing operations. These graduates may be employed by a company using high technology applications in manufacturing to perform functions related to more established operations. With additional experience and training these vocational graduates may later work directly with high technology applications.

The concept of pre-technical education at the high school level is emerging. Industry executives recognize and support this concept. One can identify alternative arrangements for the placement of this new curriculum option. It is possible that "technical preparation" could be a component of a college preparation curriculum. It might be a separate curriculum option. It might be a new component of the vocational education program.

It is quite evident that a pre-technical curriculum is related to the vocational-technical education interface with Ohio's manufacturing industries utilizing high technology applications. Regardless of where the pre-technical option is placed in the secondary school curricula, vocational education can have a significant contribution to make to this option.

Industry executives feel that the vocational education curriculum and program designed to prepare students to work in high technology applications in the manufacturing area in the future can be improved by an increased emphasis on mathematics. This includes algebra, geometry, trigonometry and pre-calculus. Some understanding of

statistical concepts is useful. More emphasis on science, especially physics, and on written and oral communication skills was suggested by industry executives.

Computer literacy, which includes the ability to write computer programs, is perceived by industry executives as essential for all students, including vocational students.

Industry executives believe emphasis in vocational education should be placed on understanding the basic technologies. For example, understanding electronics, mechanics, hydraulics and pneumatics. This basic knoledge can be translated to the specific high technology applications when the person is hired. Companies intend to do their own training for specific high technology applications.

Industry executives feel that adult education programs in vocational education addressed to industries engaged in high technology applications in manufacturing should be developed to meet the basic technology training needs of that company.

Industry Perception of Technical Education

The use of the terms "technician" and "technologies" by technical and community colleges contributes to the positive reaction of industry to these institutions as a source of personnel and training for high technology applications. There is, of course, more than terminology involved in this positive perception by industry.

High technology applications are by definition highly sophisticated technology. Hence, there is a higher level of skill required to operate and maintain high technology equipment in manufacturing.

In general, industry views the technical and community college as a key source of trained personnel. The industry executives do feel that technical and community colleges have not worked as closely as desirable with industry. They feel that advisory committees are too often a "rubber stamp" for the educators.

There is evidence in some areas that industry is providing major grants of high technology equipment for the training of degree students and for special training for industry employees. Such equipment may be worth hundreds of thousands of dollars.

Major retraining of technical and community college faculty is in progress to qualify those faculty in the high technology applications areas.

Technical educators are planning to develop curricula and programs to meet the training needs of industry in high technology applications areas. Many technical educators are

modifying existing curricula to accommodate to the high technology areas rather than developing a new curriculum. Maintaining a core of basic technical education is a prime objective. This approach is supported by the industry executives interviewed.

The Consortium Approach

While the consortium approach was not developed specifically to provide training for high technology applications, much of the effort has been directed in that area. As one would expect, there has been variation in the effectiveness of the several consortia in Ohio.

As the Ohio Advisory Council for Vocational Education reported, the consortium approach appears to be an excellent method for coordinating resources and for solving training problems. (23)

Most of the training conducted through consortium activities has been conducted in-plant with instructors drawn from industry. Vocational education and technical and community colleges have had very limited involvement in the actual training of industry personnel in high technology applications. In many cases training on high technolgy equipment is provided by the vendor of that equipment. The training package is a part of the cost of installing the system. In general, neither vocational education nor technical education faculty are qualified to conduct this training at this time.

The concept of the consortium approach has been generally attractive to industry, since part of the training costs are subsidized by state and federal funds. Probably the greatest benefit to the educational system has been the closer interaction of educators and industry training personnel created by this approach.

Advisory Committees

Industry executives strongly endorse the concept of advisory committess in both vocational and technical education. Industry personnel are most willing to serve on these committees. There is some feeling that educators do not really understand the training needs of industry and that these educators do not listen closely to what advisory committee members are saying. Many industry executives have the feeling that educators want to "sell" industry the program already developed for an area rather than being willing to modify the program to meet that industry's needs.

Adult Education Programs

Both vocational and technical educators develop adult education programs for industry. Industry continues to look to the educational system for basic courses for the up-grading of personnel. These basic courses are generally

available for employees of an industry with the company paying or reimbursing the fees and the employee attending on his or her own time. Industry executives anticipate this will continue in the future.

A significant development was noted in the in-plant training of employees in the area of high technology applications. As suggested previously, very little of this training is currently conducted by either vocational or technical personnel, and industry executives anticipate that most of this training will be conducted in-plant using industry instructors in the future. Industry executives do not feel that instructors from either vocational or technical education are qualified to conduct the very job specific training for high technology applications at this time. In many cases the training required applier to a specific manufacturer's robot or other piece of equipment.

One vocational education unit in a metropolitan area of Ohio recently worked closely with a large manufacturing plant which moved into the area. It was necessary for the plant management to retrain many journeymen electricians to operate sohisticated electronic equipment in the new plant. The vocational education unit through a well designed adult education program provided the basic education in the principles of electronics, while the plant management provided the job specific training for the workers and the equipment vendor provided training on the specific equipment. This arrangement illustrates the concept of vocational education performing an effective and needed role in the retraining of adults for high technology applications.

IMPLICATIONS FOR VOCATIONAL AND TECHNICAL EDUCTION IN OHIO

After a careful analysis of the data obtained from interviews with educators and industry executives, as well as the prior research which has been conducted, the following implications are set forth:

1. The rhetoric about high technology is pervasive throughout Ohio at the current time. The term "high technology" is widely but often inaccurately used by the media as well as educators, government and industry leaders. "High tech" has become current slang.

2. There is not a consistent or rational conceptual framework for discussing or analyzing high technology in current educational practice.

3. High technology can be defined as the "state-of-the-art" technology for the 15 to 25 percent most innovative companies in an industry. It is an ever-changing and evolving process.

4. Vocational and technical education institutions in Ohio are currently providing education and training in many high technology applications areas, particularly in the information-service areas such as business and office education. Instruction in the use of word processing equipment, microelectronic equipment and microcomputers is in evidence in both vocational and technical education institutions.

5. Additional mathematics and science (especially physics) should be provided for vocational students who are interested in working in high technology applications in manufacturing. These subjects need to be taught by teachers who are thoroughly grounded in mathematics and science and who are able to apply the appropriate concepts to high technology appications.

6. Computer literacy and improvement in oral and written communications skills are essential for vocational education students.

7. Vocational education and technical college students (and indeed all students) need to understand that additional education and training will be required as additional technological innovations are developed in each field. The concept of "lifelong learning" and career "updating" is central to continued productive employment.

8. Vocational education graduates are unlikely to be employed directly in high technology applications in manufacturing upon graduation from high school.

These persons may be employed by a company using high technology applications in manufacturing, and with additional experience and training they may later work directly with high technology applications.

9. The concept of pre-technical education is emerging for high school students interested in high technology applications in manufacturing. This education could be a part of the college preparatory curriculum or the vocational education program or it could be a separate option for high school students. Whatever arrangement is selected, it seems likely that vocational education has some contribution to make to the pre-technical option.

10. Faculty retraining and updating will be a prime requirement for both vocational and technical education as these institutions work with industries engaged in high technology applications.

11. The authority to grant an associate degree in specific technologies provides technical and community colleges a distinct advantage over vocational education departments in working with industry on high technology applications.

12. The technical and community colleges in Ohio are actively planning for training of personnel for industries using high technology applications.

13. In high technology applications in manufacturing (i.e. robotics, CAD/CAM), most of the specific training is conducted by industry using the vendors as the sources of training. Vendors sell a training package with the equipment.

14. There is a need for vocational and technical educators to emphasize representation from the 15 to 25 percent most innovative companies in each industry area on the advisory committess in that area.

15. Since the level of unemployment is currently very high, business and industry tend to seek and hire "over-qualified" persons for operators and maintenance personnel in the high technology applications in manufacturing. Future demographic trends may well create a shift away from hiring engineers to do technicians work and technicians to do vocational graduates work. It is possible some well qualified vocational education graduates may be hired directly into high technology applications in manufacturing as the economy recovers and as entry-level workers become scarce.

16. Some competition and duplication of effort continues to exist between vocational education and technical and community colleges, especially in programs for adult students.

RECOMMENDATIONS

The following recommendations are set forth based upon data obtained from interviews, as well as prior research conducted.

The Divsion of Vocational Education should:

1. Consider the role of vocational education in a pre-technical option for high school students who are interested in working in high technology applications in manufacturing in the future.

2. Conduct in-service education for vocational education personnel addressed to the role of vocational education in high technology applications.

Vocational and technical educators in Ohio should:

1. Understand the conceptual framework for analyzing the introduction of high technology innovations into business and industry.

2. Make certain that students who are interested in high technology applications in manufacturing have an opportunity to take additional mathematics, science, computer training and improve their communcation skills.

3. Develop the concept of "lifelong learning" with all students and especially those interested in high technology applications.

4. Develop procedures so that faculty re-training and updating can be achieved continuously.

5. Include representatives from innovative companies on industry advisory committees and work closely with these committees.

6. Improve the articulation between vocational and technical education, particularly for students interested in high technology applications in manufacturing.

APPENDIX A

DESIGN FOR THE STUDY

This study was an exploratory study of the relationship of vocational-technical educational institutions with business and industry using high technology applications.

Research Questions

This study was designed to answer the following questions:

1. What are the primary high technology applications that will be adopted by Ohio's business and industry sector in the next five years?

2. What have been the experiences of vocational and technical education institutions in working with industries with high technology applications?

3. What do industry executives view as the primary skills required and the educational and training requirements for current employees and "new hires" in the high technology applications in their area in the next five years?

4. How is industry meeting these educational and training requirements now?

5. Which of the education and training requirements identified by industry executives do vocational-technical educators feel they can provide in the next five years?

6. What are industry executives' perceptions of the role vocational and technical education will perform in relation to high technology applications in the future?

7. What are the implications for curricula and programs in vocational and technical education in Ohio?

Review of Research and Practice

An ERIC search was conducted through The National Center for Research in Vocational Education. While the number of recent studies on the role of vocational and technical eduction in high technology applications was very limited, several of the reports were most useful. In addition to the ERIC search, a detailed search was conducted

through the LCS (computerized library circulation system) of The Ohio State University Libraries. In addition, use was made of the computer link to the OCLC (On-line Computer Library Center) to search for information at research libraries other than the Ohio State University.

The Executive Director of the Ohio Advisory Council for Vocational Education provided a report of activities under way in other SACVEs in the United States.

Instrument Development

Structured interview forms were developed based upon the review of literature and the research questions for this study. These instruments were reviewed by the staff of the Ohio Advisory Council for Vocational Education prior to their use. A separate instrument was used for the interviews with educators and with executives in industry.

Data Collection

Personal interviews with educators and with industry executives were conducted. The principal investigator traveled to the site of the educator or the industry executive for these interviews. Each interview lasted approximately one hour. There were thirty-two interviews with university, technical college, community college and vocational educators. Several consortium directors were interviewed. Fifteen industry executives were interviewed. (A list of those interviewed is shown in Appendix B). The principal investigator participated in the pre-convention workshop conducted by the American Vocational Association at St. Louis, Missouri in December, 1982. This workshop was entitled, "Preparing Students for High Technology Careers." In addition, the principal investigator attended the "Computer Fair" held by the Ohio Department of Education in December, 1982.

1. The Division of Vocatioal Education was asked to identify vocational schools and consortium personnel with experience in working with high technology applications.

2. The Ohio Board of Regents staff identified technical and community colleges that had experience working with high technology applications.

3. The Ohio Department of Development was asked to identify industries that were involved in high technology applications.

4. All interviews with educators were conducted prior to those conducted with industry executives.

5. The industry executives selected represented different types of high technology applications, different geographical areas of the State of Ohio

(but primarily urban centers) and different degrees of interaction with the components of the educational system.

The interviews with educational personnel were conducted in November, 1982 and the interviews with industry executives were conducted in December, 1982 and January, 1983.

Data Analysis

Since this was an exploratory study, no sophisticated statistical measures were used. The data were analyzed by the principal investigator. Where conclusions and implications have been set forth, these are based upon a clear concensus of respondents. Concensus is interpreted to mean that not less than 75 percent of the respondents agreed with a given implication.

Interpretation of Data

Since this study was designed to investigate the role of vocational and technical education working with high technology applications in Ohio's business and industrial sector, all data must be interpreted within that context. The implications are applicable to the areas of high technology applications specified. While there are some references to the information-service areas, most of the implications are directed toward high technology applications in manufacturing.

Panel of Reviewers

When the draft of the final report was completed, a panel of reviewers was convened by the Ohio Adivsory Council for Vocational Education to comment on the implications and recommendations set forth in this report. This panel was composed of eleven vocational and technical educators from over the State of Ohio who spent approximately two hours commenting on various aspects of the report.

Final Report

A second draft of the final report was prepared for review by the staff of OACVE. This second draft included revisions based upon the discussion with the panel of reviewers.

Twenty-five copies of the revised final report were prepared for presentation to the Ohio Advisory Council for Vocational Education.

The final report was prepared on a 64K microcomputer using a word processing software package with a dot-matrix printer.

APPENDIX B

Educators and Government Personnel Interviewed October-November, 1982

Dr. William Ashley, Research Specialist,The National Center for Research in Vocational Education

Dr. David Ballinger, Vice President for Academic Affairs, Cincinnati Technical College

Mr. Ron Bornman, Mid-Central Ohio Consortium Director

Dr. Harold Carr, Superintendent, Great Oaks Joint Vocational School District

Dr. Charles Dygert, Supervisor of Training Services, Business and Industrial Development, Division of Vocational Education

Mr. Jack Ellis, On-site Training Coordinator, Rockwell International

Dr. James Frasier, Director of Vocational Education, Dayton City Schools

Mr. Robert Hadden, Consortium Director, Central Ohio

Dr. Ted Herklotz, Director of Vocational Education, Cincinnati City Schools

Mr. Robert Hughey, Director of Vocational Education, Akron City Schools

Dr. Henry Hunker, Professor of Urban Geography,The Ohio State University

Mr. Charles Hunt, Director of Adult Education, Penta County Joint Vocational School District

Dr. Russell Jerd, Dean, Engineering Technologies, Sinclair Community College

Dr. Bonnie Johnson, Dean, Public Service, Technical Division, Sinclair Community College

Dr. Leonard Kingsley, Superintendent, Penta County Joint Vocational School District

Dr. Rosemary Kolde, Administrative Specialist, Great Oaks Joint Vocational School District

Dr. Ivan Kurtz, Provost, Owens Technical College

Dr. James P. Long, Senior Research Specialist,The National Center for Research in Vocational Education

Dr. A. J. Miller, Acting Associate Dean, College of Education, Ohio State University

Dr. William Miller, Administrator, Two Year Campuses,The Ohio Boarc of Regents

Dr. Carrell Parks, Director, Division of Vocational Education

Mr. David Petersilge, Consortium Director, Medina, Portage and Summit Counties

Dr. Robert Redmond, Associate Dean, College of Engineering,The Ohio State University

Dr. Albert Salerno, Dean of Instruction, Clark Technical College

Mr. Thomas Scherer, Consortium Director, Toledo Area

Dr. Kenneth Searfoss, Director of Vocational Education, Toledo City Schools

Dr. Ned Sifferlin, Vice President, Sinclair Community College

Mr. Marion Smith, Associate Dean, College of Engineering,The Ohio State University

Mr. Robert Tait, Assistant Director, Engineering Experiment Station,The Ohio State University

Mr. Nick Topougis, Director of Career Education, Akron City Schools

Mr. John Venters, Industrial Training Office, Ohio Department of Development

Dr. Howard Washka, Assistant Dean of Instruction, Lorain Community College

Industry Executives Interviewed

December, 1982 - January, 1983

F. J. Ballenger, Director of Personnel, The Fairfield Engineering Company, Marion, Ohio

Dale Baker, Director, Chemical Abstracts, Columbus, Ohio

George Baughman, Consultant, Technology and Productivity Center of Ohio, Columbus, Ohio

Mark Bobes, Manager, Manufacturing Training, Goodyear Tire and Rubber Company, Akron, Ohio

Charles Brinkman, Vice President, Brinkman Tool and Die, Dayton, Ohio

James Brown, Director of Training, Ford Motor Company, Batavia, Ohio

George Foster, Chairman, Autech, Worthington, Ohio

Jane Frederick, Staff Engineer, Mead Digital Systems, Dayton, Ohio

E.W. Kissell, Director, Goodyear Technical Center, Akron, Ohio

Steven A. Lucas, Quality Project Manager, AccuRay, Columbus, Ohio

James Mack, Director of Training, AMC/Jeep, Toledo, Ohio

David Meyer, Director of Technical Training, Rockwell International, Columbus, Ohio

Theodore G. Montague, President, Peerless Saw Company, Groveport, Ohio

Frank R. Polichene, Manager, Corporate Plant Planning, Goodyear Tire and Rubber Company, Akron, Ohio

Ronald C. Reeve, Chairman, Advanced Robotics, Hebron, Ohio

Additional Data Sources

1. Pre-Convention Workshop-American Vocational Association, December 2, 1982, St. Louis, Missouri.

"Putting a High Technology Core into Your Vocational Program"
Dr. Dan Hull, President, Center for Occupational Research and Development, Waco, Texas.

"Robotics Tech Education Start-up"
Prof. Edward J. Konopka, Oakland Community College, Auburn Heights, Michigan

"The State Role in Implementing a High-Tech Program."
Dr. John Lloyd, Director of Program Development, Office of Vocational Education, Georgia Department of Education

2."Computer Fair"--Conducted by the Ohio Department of Education, December 6-7, 1982, Columbus, Ohio

"Technology in the Future"
Dr. Jules Duga, Battelle Laboratories, Columbus, Ohio

"Computer Literacy"
Ms. Ellen Richman, Chagrin Falls Public Schools

"Teaching Mathematics and Computer Understanding"
Dr. Richard J. Shumway, College of Education, Ohio State Unviersity

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3. Ibid.

4. Charles P. Alexander, "Bad Tidings for the Jobless," Time, December 13, 1982, pp.54-55.

5. Christopher Freeman, John Clark and Luc Soete, Unemployment and Technical Innovation. (London: Frances Pinter, Ltd., 1982), p.10.

6. Alexander, "Bad Tidings for the Jobless," pp.54-55.

7. Christopher Byron, "Big Steel's Winter of Woes," Time, January 24, 1983, pp. 58-59.

8. U.S., Congress, House, Committee on Science and Technology, Local Incentives for High Technology Firms and Innovation. Hearing before a subcommittee of the Committee on Science and Technology, House of Representatives, 97th Cong. 2nd sess., 1982.

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12. A University-Industry Relations Program in the State of Ohio. Final Report to the Ohio Board of Regents, (Columbus: The Ohio State University, June, 1967), pp. A-11 to A-20.

13. John H. Lloyd, "The State Role in Implementing A High Technology Program." A paper presented at the American Vocational Association Workshop, December 2, 1982.

14. This section draws upon Maurice Goldsmith, (ed.), Technological Innovation and the Economy. (London: John Wiley and Sons, Ltd., 1970).

15. Constance Faddis, William L. Ashley and Robert E. Abram, Preparing for High Technology: Strategies for Change. (Columbus: The National Center for Research in Vocational Education, The Ohio State University, 1982).

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17. Frederic Golden, "Big Dimwits and Little Geniuses," Time, January 3, 1983, p. 30.

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